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ABSTRACT

This guide provides detailed information, resources, and activities to teach students about the bats of Arizona. Chapters include: (1) "What is a Bat?"; (2) "Megabat or Microbat?"; (3) "Bat Anatomy"; (4) Diet and Feeding"; (5) Echolocation"; (6) Reproduction and Lifespan"; (7) "Flight"; (8) "Migration and Hibernation"; (9) Habitat and Roost Sites"; (10) "The Benefits of Bats"; (11) "Bats in Myth and Folklore"; (12) "Action Projects"; (13) "Elementary Bats Quiz"; (14) "Rain Forest Allies Quiz"; (15) "Big-eared Bat Book"; (16) "Classify a Chiropteran"; (17) "Bats Eat Bugs"; (18) "What Do Animals Do in Winter"; (19) "Wildlife in Winter"; (20) "Hibernation in a Hibernaculum"; (21) "Bat Jeopardy"; (22) "Build a Bat"; (23) "Bat Menu"; and (24) "Bat Biologist Field Equipment." Each chapter contains teaching tips. (CCM)

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Guide to the BATS Resource Trunk

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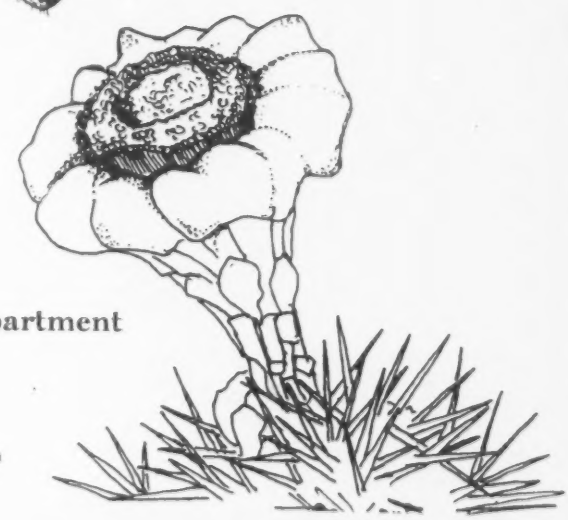

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Dear Educator,

The Arizona Game and Fish Department Education Branch is pleased to bring you the BATS Resource Trunk. We hope the trunk components and this guide will assist you in helping students to learn about some of Arizona's most fascinating wildlife species – bats.

This project was made possible through the *WILD In The City* Initiative, funded by National Fish and Wildlife Foundation and the Phillips Petroleum Foundation. The focus of the grant program is to provide environmental education resources to urban schools, utilizing the Project WILD network. I would like to acknowledge a team of dedicated Phoenix educators from the Cartwright and Osborn school districts who were instrumental in the development and creation of this resource. A special thanks to: Bev Meighan, Saralou Satton, Maria Merlino, Pat Keopp, Loretta Haught, and Lori Stoll for their assistance in selection of items for the trunk and development of the curriculum framework for this guide. I would also like to thank Brian Vasiloff for creating the wonderful artwork included in the guide.

Bat Conservation International and AIMS (Activities Integrating Mathematics and Science) granted permission to have their activity guides included in the BATS Resource Trunk. For more information about Bat Conservation International, call 1-800-538-BATS. For information about other activity guides available through AIMS, call 209-255-4094.

Again, we hope this resource assists you in helping students learn about Arizona wildlife. For information about other resources available from the Arizona Game and Fish Department call 602-789-3220.

Sincerely,

Sandy Reith

Sandy Reith
Project WILD Coordinator

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Resource Materials

- √ spotted bat puppet
- √ Mex. free-tailed bat puppet
- √ fruit bat puppet
- √ *Elementary Bats*, video
- √ *Elementary Bats Quiz*, pg. 16
- √ WILD Kids – *Big-eared Bat Book*, pg. 18.
- √ art supplies

Teaching Tips

Use the bat puppets to show:
Three of the over 950 species (kinds) of bats.

Bats are mammals – they have hair, control their body temperature, bear live young, and nurse their young.

All bats have eyes and can see. Fruit bats see very well.

Bats have wings and are the only mammals that can fly.

Bats have a thumb and four long fingers.

Activities

WILD Kids – Big-eared Bat Book
Students make a bat book. (Make one copy per student.)

Create A Bat Fact Book
Ask students to create their own book based on bat facts.

Elementary Bats – video & quiz
Students watch a video about bats, then test their Bat I.Q.

Classify A Chiropteran – for older students, pg. 20.

What Is A Bat?

Concept: Bats share characteristics with other mammals, but are unique in that they are the only mammals with true flight.

Bat facts

- Bats are mammals – they have hair, bear live young, nurse their young, and are endotherms (they produce their own body heat internally).
- There are about 950 species of bats.
- Bats make up almost 1/4 of the world's 4,444 species of mammals.
- Bats are not blind – some species have very good vision.
- Bats are primarily nocturnal – they are active at night when there is little competition from other animals for food sources.
- Bats are the only flying mammals – they don't glide, like a so-called "flying squirrel" or a "flying lemur." They provide their own power and generally control their own flight plan.

Bats go way back
The origin of bats is not well understood. However, fossil records of bats dating back 55 million years suggest that bats have changed very little over time compared to other mammals. Although there is much discussion as to the origin of bats, it revolves mostly around the origin of the wing and how it developed to sustain flight.

How are bats classified?

Kingdom – Animalia

Phylum – Chordata

Class – Mammalia

Order – Chiroptera
(Suborders = Megachiroptera and Microchiroptera)

Family –18 families of bats
(1 Megachiroptera, 17 Microchiroptera)

Genus – 180 genera of bats

Species – 950 species of bats

In Arizona, we have representatives in 4 families, 15 genus, and 28 species.

These materials developed and provided by the Arizona Game and Fish Department Education Branch.

Megabat or Microbat?

Concept: Bats can be classified (grouped) according to similar characteristics.

Bats are the only members of the order Chiroptera, chiro = hand, ptera = wing. Chiropterans are arranged in two suborders, the Megachiropterans (megabats), and Microchiropterans (microbats). In general, the megabats are large and the microbats are small, but some megabats are as small as any of the microbats, and some Microchiropterans are quite large.

Megabats

- All 170 species of megabats belong to the same family (Pteropodidae).
- They inhabit the tropics and subtropics from mainland Africa east to Australia and the smaller Pacific islands.
- Megabats are mainly fruit-eaters (frugivores) – although some also eat nectar (nectarivores), or insects (insectivores).
- They locate food by sight, and have well-developed eyes.
- Fruit-eating bats have a good sense of smell, which helps in locating fruit at close range.
- Some megabats have wingspans of up to 6 feet – this comes in handy for flying from island to island in search of fruit.

Microbats

- There are about 780 species of microbats, in 17 families.
- They are found worldwide except for the frozen, polar areas and some small islands.
- Microbats use echolocation to navigate in the dark and locate food.
- Nearly all microbats have small eyes. Some have noseleaves or specialized ears to assist in echolocation.
- Most microbats are insectivores.
- Some microbats are nectar-feeders (nectarivores).
- A few species of microbats are carnivores – they are adapted to feeding on small mammals, frogs, or birds.
- A few species of microbats are fish-eaters (piscivores).
- Three species of microbats feed on blood (sanguivores).

Resource Materials

- √ spotted bat puppet
- √ Mex. free-tailed bat puppet
- √ fruit bat puppet
- √ fruit bat skull
- √ insect-eating bat skull
- √ magnifying glasses
- √ *Bat Jeopardy*, Teacher packet
- √ *Bats; Myth and Reality*, video

Teaching Tips

Use the bat puppets to show:
Microbats (spotted bat and Mexican free-tailed bat) have large ears and small eyes. They locate insects by echolocation.

Fruit bats are megabats and have small ears and big eyes. They locate fruit by sight.

Use the bat skulls to show:
Insect-eating bats have teeth designed for cutting up insects.

Fruit bats have teeth designed for crushing fruit.

Activities

Microbat or Megabat?
After watching the video, *Bats; Myth and Reality*, ask students to make a list of the characteristics of microbats and a list for megabats. Then make a list of the characteristics they both share.

Bat Jeopardy
Students watch the video *Bats; Myth and Reality*, then play *Bat Jeopardy* to test their bat I.Q.

Resource Materials

- √ bat skeleton
- √ fruit bat skull
- √ insect-eating bat skull
- √ plastic bat & *The Bat Book*
- √ magnifying glasses
- √ tooth picks or pipe cleaners
- √ glue

Teaching Tips

Use the bat skeleton to show:
Bats have many of the same bones people have.

Bats have a thumb and four long fingers. Point out the similarities and differences between the bat skeleton and a human skeleton.

The free-tailed bats have a tail that extends beyond the tail membrane.

Use the plastic bat to show:
Bats have a brain, heart, lungs, and digestive system.

Use the bat skulls to show:
Insect-eating bats have teeth designed for cutting insects.

Fruit bats have teeth designed for crushing fruit.

Activities

Build a Bat Skeleton
Ask students to construct a bat skeleton using tooth picks or pipe cleaners, and glue. Then, ask students to label the parts of the skeleton.

Bat Anatomy

Concept: Bat anatomy is similar to that of other mammals, but the adaptation of flight accounts for the unique form and appearance in bats.

Wings

Chiroptera is a Greek word that means "hand wing." The wing can be compared to a human arm and hand, but the bat's forearm is much longer. Bats have 4 elongated fingers that stretch skin into wings, plus a thumb.

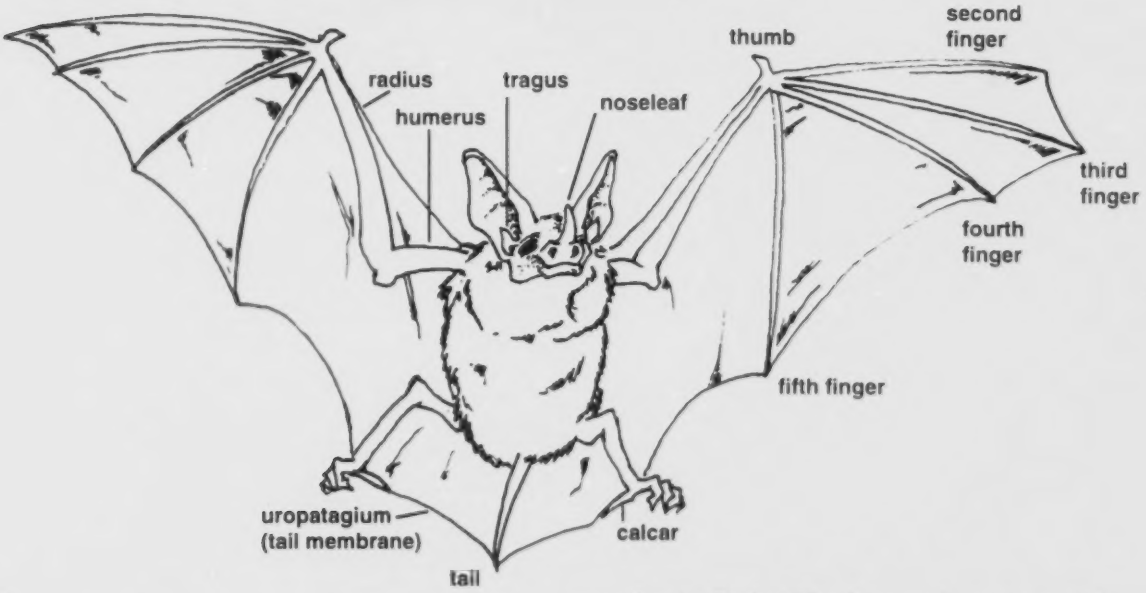
The wings are made of a flexible membrane that is very thin but elastic. It is about equal in strength and elasticity to a plastic sandwich bag. Punctures to the membrane appear to heal rapidly. Blood vessels in the wings carry nutrients and oxygen to the flight muscles. In some bats, the wings are used to deflect insects toward the bat's mouth. The wings are also used to warm or cool the bat.

Bat wingspans range from about 6 inches, to almost 6 feet. The size and shape of a bat's wings indicate flight type. In general, bats with relatively short, broad wings are slow flyers. Bats with long, narrow wings are generally fast flyers. Mexican free-tailed bats have long, narrow wings and are strong, fast flyers. They can fly 65 miles an hour and have been known to travel over 800 miles in their biannual migration from Arizona to Mexico.

Head

Bats have an amazing variety of head shapes. In general, insect-eaters have small eyes, and a moderately long, pointed nose. Fruit-eaters have various head shapes. The Old World fruit bats have a widely rounded head with a long, pointed snout. The wrinkle-faced bat has a broad, flat, monkey-like face and a high-domed head. In nectar-feeders, the snout is long and tubelike. Fish-eaters have a bulldog shaped head with a short face and a high-domed head.

Bat Anatomy



Eyes

All bats can see. Microbats rely heavily on echolocation for navigation and usually have small eyes. The megabats navigate by vision and have large eyes. Nectar-feeders have relatively large eyes also. All bats lack cones (light sensitive cells in the retina).

Ears

Hearing is an important sense for nocturnal, flying animals. Microbats navigate by echolocation and have great variation in ear shape and size. Most microbats have a tragus – a piece of cartilage above the ear notch. Megabats navigate by vision and generally have short, rounded ears.

Noseleaves

Some microbats have leaflike flaps of skin in the nose region. These noseleaves – some are quite elaborate – are believed to help direct the echolocation sounds produced by bats.

Body Shape and Size

Bats have a flattened, tapered, aerodynamic body shape. The chest and back are composed of heavy flight muscles used to operate their wings. In contrast, birds use only chest muscles in flight. The largest bat, a type of fruit bat, has a wingspan of up to 6 feet. The smallest bat, the bumblebee bat or Kitti's Hognose bat, has a wingspan of 6 inches. In general, fruit-eating and carnivorous bats are large in size, whereas insect-eaters are commonly smaller than fruit-eaters.

Hindlimb and Foot

Unlike most mammals, a bat's knee is directed backward and upward. This posture would not support the weight of a walking mammal, but works quite well for animals that hang upside down. Bats also have specially designed tendons in the hindlimbs. The weight of the hanging bat allows the toes and toenails to grasp a foothold in the roost while the bat sleeps.

Tail

Just like ear size, tail size varies in bats. "Evening bats" such as the pallid bat and species of *myotis* have long tails that are bound within the tail membrane (uropatagium). In the free-tailed bats, most or all of the tail extends beyond the uropatagium. Most of the fruit-eating bats do not have much of a tail.

Resource Materials

- √ spotted bat puppet
- √ Mex. free-tailed bat puppet
- √ fruit bat puppet
- √ fruit bat skull
- √ insect-eating bat skull
- √ magnifying glasses
- √ WILD Kids – *Bats Eat Bugs*, pg. 22.
- √ art supplies

Teaching Tips

Use the bat puppets to show:
The spotted bat and Mexican free-tailed bat are insect-eaters. They have small eyes and large ears.

Fruit bats have big eyes and a long nose.

Use the bat skulls to show:
Insect-eating bats have teeth designed for cutting insects.

The fruit bat skull has teeth designed for crushing fruit.

Activities

WILD Kids – Bats Eat Bugs
Students learn about bat diets, write a bat poem, and draw cartoon bats.

Bats Like Bugs!
Insect-eating bats can eat half their weight in insects each night. How many quarter pounders would each student have to eat each day to equal half their weight? (Number of quarter pounders = students weight x .5 x 4)

Diet and Feeding

Concept: Bats have special adaptations that allow them to use a variety of food sources.

Insectivores (Insect-eaters)

- 70% of all bats are insectivores.
- Insect-eating bats use echolocation to track and capture their prey.
- Insect-eating bats usually have large ears and small eyes – but all bats can see, none are blind.

Hunting Techniques:
Aerial insectivory – the bat waits on a perch until it locates prey by echolocation, then flies out after it. In another form of aerial insectivory, the bat hunts while in flight, for long periods of time. The Greater Western mastiff bat uses this type of foraging.

Foliage gleaning – the bat scans for insects and spiders on plants, then drops onto the vegetation to capture them. The long-eared myotis is a foliage gleaner.

Terrestrial acquisition – the bat flies close to the ground, scanning for insects and scorpions. The prey is eaten on the ground or taken to a perch. Pallid bats use this feeding style.

Frugivores (Fruit-eaters)

- 23% of all bats are frugivores.
- Frugivores use their vision and sense of smell to locate food.
- Fruit-eaters usually have large eyes and a long snout.
- They feed on wild fruit such as figs, and cultivated fruits such as mangos, papayas, bananas, peaches, and other tropical fruits.
- Fruit-eaters disperse the seeds of tropical plants.
- The seeds of some tropical fruits will not germinate unless they have passed through the digestive system of a bird or bat.

Diet and Feeding

Nectarivores (Nectar-feeders)

- 5% of all bats are nectar-feeders.
- Nectar-feeding bats have a long snout and a long, slender tongue for collecting nectar.
- They collect pollen on their head and shoulders as they travel from flower to flower, transporting pollen grains, pollinating flowers.
- Many plant species have flowers that attract nectar-feeding bats: they open at night, are whitish in color, and have a strong musky odor.

Carnivores (Meat-eaters)

- 0.7% of all bats are carnivores.
- They eat small rodents, lizards, frogs, fish, and other bats.
- The frog-eating bat recognizes the call of the frog it eats. When it flies over a group of calling frogs, the frogs stop calling. Those that don't, become food for a hungry bat.
- Fish-eating bats (piscivores) have long legs and sharp, hooked claws. They locate their prey by using echolocation to detect ripples in the water. They swoop down, grasp a fish with their hooked claws, and quickly transfer it to their mouth.

Sanguivores (Blood-feeders)

- Only $^{3}/_{10}$ of 1% of all bats feed on blood. There are only 3 species of vampire bats: The White-winged vampire, The Common vampire, and The Hairy-legged vampire.
- Vampire bats are found in Mexico, Central America, and South America.
- Vampire bats use their sharp incisors to make a small, V-shaped wound on their victim – usually a cow, horse, goat, or chicken.
- An anticoagulant in the bat's saliva keeps the blood flowing while the bat laps it up.
- A vampire bat can drink 2 tablespoons of blood each night.
- After feeding, the vampire bat crawls away and urinates until it is light enough to fly.
- Unlike most bats, vampire bats are adapted to moving on the ground.

Resource Materials

√ Bat Lunch Box
√ art supplies

Teaching Tips

Discuss with students how bats are adapted to a wide variety of food sources such as:

Insect-eating bats use echolocation to find insects.

Fruit-eating bats use sight and smell to locate fruit. (Show students the contents of the Bat Lunch Box.)

Nectar-feeding bats use smell and sight to locate flowers with nectar.

Frog-eating bats use hearing to locate their prey.

Vampire bats use smell, hearing, and sight to locate their prey.

Activities

Awesome Appetites!

Some fruit bats can eat twice their weight in food each day. How much food would each student have to eat to equal 2 times their weight in food each *week*? People eat ~1/32 of their weight/day. Ask students to compute 1/32 of their body weight.

Bat Menu

Ask students to design a menu listing the different foods bats eat.

Resource Materials

- √ spotted bat puppet
- √ Mex. free-tailed bat puppet
- √ fruit bat puppet
- √ *Bat Chat*, audio tape
- √ slinky
- √ art supplies

Teaching Tips

Use the bat puppets to show:
Bats that echolocate (such as the spotted bat and Mexican free-tailed bat) usually have large ears and small eyes.

Play selected sections of the audio tape – "*Bat Chat*." This is a technical tape. Make sure you select parts that are suitable for your grade level.

Use the slinky to demonstrate echolocation. As the slinky flows to one hand, this represents the high-pitched sounds a bat sends out. As the slinky flows back to the other hand, this represents the sound waves bouncing off objects and back to the bat.

Activities

Create A Better Hearing System
Tell students about the special hearing system bats have, then ask them to design a better way of hearing for people.

Echolocation

Concept: Some bats have a special hearing system which they use to locate food and to navigate in the dark.

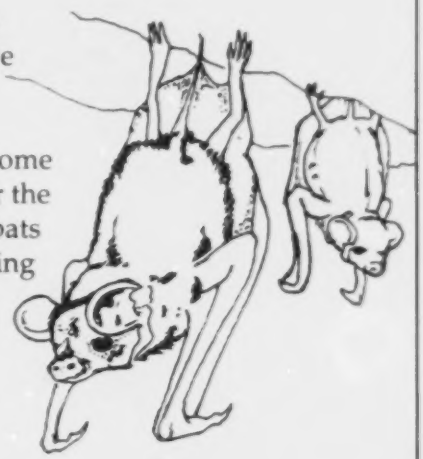
Microbats use *echolocation* to locate prey and navigate in the dark. In echolocation, bats send out pulses of sound that bounce off objects and return to the bat as echoes. The sounds are generated in the bat's larynx and emitted through its mouth or nose. This is why bats often fly with their mouths open. Normally, we cannot hear these sounds because they are ultrasonic (high-pitched).

- Through echolocation, a bat can tell the size, shape and texture of an object and determine if the object is moving.
- Some bats can detect an object as small as a human hair.
- Echolocation is used to detect objects that are less than a few yards away.
- Some bats that echolocate have elaborate noseleaves (flaps of skin on the nose) that may serve to direct the echolocation sounds.
- A species of megabat, the Egyptian fruit bat, is believed to use echolocation to navigate through dark caves.

Reproduction and Lifespan

Concept: Bats have adapted to their environment in ways that allow them to survive and maintain their numbers.

Most bats have only one baby (pup) each year, but some have twins or even four pups in a litter. The gestation period varies from 40 to 60 days for some small bats, to eight months for the Common vampire bat. Some bats give birth to pups while hanging upside down, others pull themselves into a horizontal position. Bats with a tail membrane curl it around the pup as it is being born.



- Newborn bats are helpless and depend on their mothers for one to three months after birth.
- Like all mammals, female bats nurse their young.
- Pups have special milk teeth to grasp their mother's nipple, even when in flight.
- Megabat pups are born 20-30% of adult size, with fur, and their eyes open.
- Microbat pups are born at about 10-15% of adult size, naked, with their eyes closed.
- Most bats leave their young behind when in flight, although some of the large fruit bats may carry their young with them.
- When female Mexican free-tailed bats go out to feed, they leave their pups in nursery colonies – this provides the cluster of pups with sufficient body heat and humidity. A female identifies her pup by its scent and by a distinctive sound it makes.
- Most bats live 8 – 10 years, but some live 30 years or more.

Resource Materials

√ *Stellaluna*, storybook
√ *Bats; Creatures of the Night*, storybook, pg. 20-34.

Teaching Tips

Read the book *Stellaluna*, the story of a young fruit bat, and *Bats; Creatures of the Night*, the story of the birth and first month in the life of a little brown bat.

Activities

A Day in the Life of a Bat Pup. After reading *Stellaluna* and *Bats; Creatures of the Night*, ask students to compare the life of a young fruit bat to that of a young insect-eating bat. Then, ask students to create a page in a diary about the life of a young fruit bat or insect-eating bat.

Megapups!
At birth, an insect-eating bat weighs 10-15% of its mother's weight. Newborn fruit bats weigh 20-30% of their mother's weight. How much would a human baby weigh if it weighed 10%, 15%, 20%, or 30% of its mother's weight? Ask students to compute what per cent of its mother's weight a *human* baby weighs? (% = babies weight x 100, divided by mother's weight).

Resource Materials

- √ bat skeleton
- √ Mex. free-tailed bat puppet
- √ fruit bat puppet
- √ magnifying glasses

Teaching Tips

Use the bat puppets to show:
Bats have wings made of skin stretched between the fingers.

The tail membrane is used by some bats to direct insects into their mouth.

Some bats (Mex. free-tailed bats) have long, narrow wings and are fast, high flyers. Others have short, broad wings and are built for maneuverability.

Use the bat skeleton to show:
Bats have four, thin, elongated fingers that make up the framework for the wing.

Bat bones are light weight but are not porous like bird bones.

Activities

Compare yourself to a bat
Ask students this: If a bat flaps its wings 16 times per second, how many times does it "flap" in 15 seconds (15 x 16 = 240 per 15 sec.). Now, ask students to "flap their wings." How many times can they flap in 15 seconds? An active bat's heart rate may reach 900 beats per minute. Ask students to take their heart rate before and after doing jumping jacks.

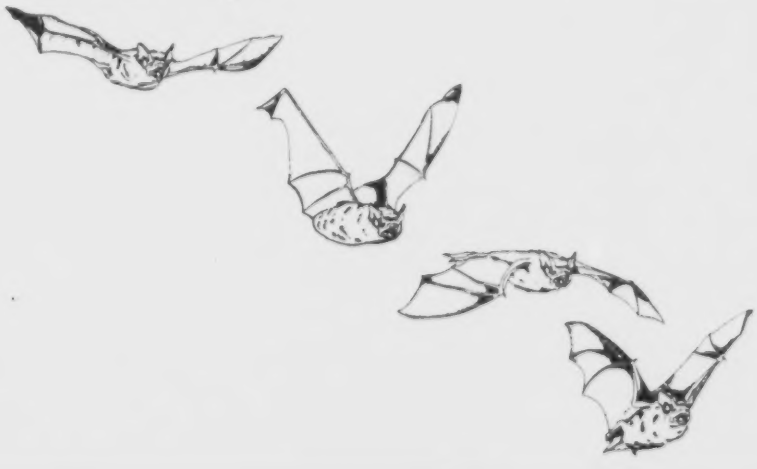
Flight

Concept: The adaptation of flight allows bats to occupy a variety of habitats and utilize a variety of food sources.

For most bats, flight is their only way of getting around (a few species, such as the pallid bat and vampire bats, can walk on their elbows and wrists). Wings provide bats the aerodynamic lift required for flight, and the propulsion for sustained flight.

- Bats are built for flight – they have a streamlined body shape, powerful chest and back muscles, and wings.
- A bat uses its wings to pull itself through the air, the same way a swimmer pulls herself through water.
- A bat's wings are made of a leathery membrane that stretches between the bat's fingers and attaches to its back legs.
- In some bats, a membrane (the uropatagium) stretches between the hind legs and the tail, increasing the flight surface area.
- Bats launch into flight by releasing their grasp from their roost site – some bats begin flapping their wings right away, others free fall before beginning to flap their wings.
- Large bats may flap their wings 20 times per minute when flying.
- Small bats flap their wings up to 16 times per second!

The benefits of flight include: the ability to utilize flying insects as a food source, a means of escape from predators, long distance migration, and use of roost sites unavailable to animals without flight.



Migration and Hibernation

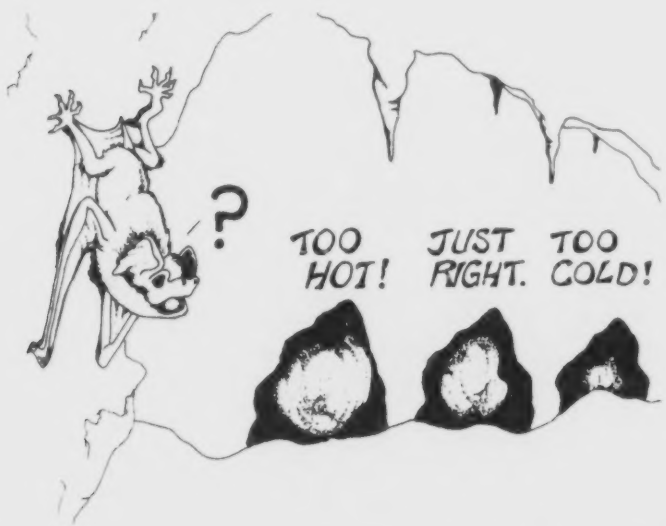
Concept: Bats are adapted to changing weather conditions.

When the weather turns cold and food is unavailable, some bats travel to warmer climates. They return when conditions are favorable and food is once again available. This process is called *migration*.

- Mexican free-tailed bats travel 800 miles during their biannual migration from Arizona to Mexico. They travel at night and spend the days in roost sites along the way.
- Migrating little brown bats cover 20 miles each night.

Some bats *hibernate* in winter. During hibernation, a bat's heart rate and breathing nearly stop. In the months prior to hibernation, bats put on extra fat by eating twice as much food as normal. They can live off these fat reserves for many months while in hibernation. But if a hibernating bat is disturbed, it may wake up and use up all its fat reserves needed to keep it alive until spring. Hibernating bats should never be disturbed.

- A little brown bat's heart rate decreases from almost 900 beats a minute when active, to about 30 beats per minute when hibernating.
- A hibernating big brown bat's body temperature may drop from 100° F down to almost 32° F.



Resource Materials

√ WILD Kids – *Hibernation In A Hibernaculum*, pg. 28
√ WILD Kids – *Wildlife In Winter*, pg. 26.
√ WILD Kids – *What Do Animals Do In Winter?*, pg. 24

Teaching Tips

Explain to students the reason animals migrate or hibernate is to avoid food shortages and cold weather.

Explain that hibernation is more than just sleeping. The animal's heart rate slows and body functions cease.

Discuss some of the ways people adjust to hot or cold weather conditions.

Activities

WILD Kids – Hibernation In A Hibernaculum
Students compute the changing body temperature of a bat as it awakens from hibernation.

WILD Kids – Wildlife In Winter
Students learn how bats and other animals are adapted to winter conditions.

WILD Kids – *What Do Animals Do In Winter?*
A book-making activity for younger students.

Resource Materials

- √ *Build A Bat* Activity, see Teacher packet
- √ *Bat Cave Habitat*, see Teacher packet

Teaching Tips

Discuss with students four things that all animals (people included) need in their habitat: food, water, shelter, and space. Discuss how students' habitat needs are different from a bat's, and how they are the same.

Explain that bats can sleep hanging upside down because they have special valves which keep the blood from rushing to their head.

Activities

Build A Bat
Students learn how bats are adapted to their habitats, then create a bat in its habitat.

Bat Cave Habitat
Students construct a bat cave habitat using paper plates.

Build A Bat Habitat
After students have learned about bat habitats, try turning your classroom into a cave. Use paper and cardboard to make stalagmites and stalactites. Add some bats and include predators such as owls, snakes, and beetles.

Bat Habitat and Roost Sites

Concept: Bats live almost everywhere on earth where suitable habitat exists.

Bats are found on every continent except Antarctica. They live in all habitat types, from desert to the treeline. Bats are normally not found above the timberline, probably due to the lack of roost sites.

- Megabats live where fruit is available, in tropical and subtropical climates, from mainland Africa east to Australia and the smaller Pacific islands.
- Microbats live in all habitat types except the frozen, treeless, polar areas and some small islands.

Roost sites are places where bats spend the day and/or evening. Bat roost sites include mines, bridges, buildings, trees, and most commonly caves. Roost sites provide specific temperature and humidity levels for bats. Some bats prefer hot, humid caves. Others prefer cooler, drier roost sites.

- In general, smaller species of bats roost in large colonies. This provides the bats protection from predators (owls, snakes, etc.) and reduces loss of body heat and moisture.
- Some larger species of bats roost out in the open in trees.
- Bats spend long periods of time in day roosts. These roost sites may contain large quantities of guano (bat excrement).
- Night roosts are used as stopovers between foraging outings and they often contain discarded insect and fruit parts, and guano.
- Hibernation roost sites, called *hibernacula*, provide constant temperature and humidity levels for hibernating bats. Hibernating bats should never be disturbed.

In Arizona, all bats are protected by law. It is illegal to trap, kill, harm or keep bats except by special permit.

The Benefits of Bats

Concept: Bats are important in ecological systems and contribute to the functioning of the overall system.

- Some species of bats can eat 3,000 insects in one evening and can eat half their body weight in insects each night.
- A colony of 20 million Mexican free-tailed bats can eat a quarter of a million pounds of insects in one night!
- Bats pollinate and disperse the seeds of many plants including: bananas, mangos, figs, guavas, peaches, avocados, cashews, cloves, kapok, balsa wood, and sisal (for rope-making).
- In Arizona, nectar-feeding bats are important pollinators of agave plants and columnar cacti such as saguaro and organ pipe.
- Some plants have specially adapted flowers that attract bats. The flowers open at night, are white in color and have a scent that attracts bats, or have flowers that hang so bats can hover above them and avoid cactus spines.

Bats are important in medical research:

- Bat can survive low body temperatures for extended periods while in hibernation. This may provide doctors with techniques for lowering the human body temperature during surgery.
- Bats have been used to study the effects of drugs and alcohol on blood vessels and nerves. The bat wing membrane is so thin that bacteria growth can easily be tracked and studied in the circulating blood of the wing.
- Because some bats seem to be resistant to certain viruses, they may become an important factor in the development of vaccines.
- Studies on bat echolocation may provide scientists with a way of developing ultrasonic orientation for the blind.
- The anticoagulant in vampire bat saliva is being studied to help treat human heart patients.

Bats and biologists:
Bat biologists study bats to learn more about bats and their habitat. By studying the changes in bat populations, biologists can learn about the quality of the habitat. It is recommended that anyone conducting bat surveys receive the rabies vaccine.

Resource Materials

- √ Bat Lunch Box
- √ *Rain Forest Allies*, video
- √ *Rain Forest Allies Quiz*
- √ fruits of tropical plants
- √ *Bat biologist field kit*

Teaching Tips

Use the Bat Lunch Box to show different products that come from plants that bats pollinate or disperse the seeds.

Activities

Rain Forest Allies – video & quiz
Students watch a video about bats and the rain forest, then test their Bat I.Q.

Make A Bat Fruit Salad
Ask students to bring in fruits from plants that bats pollinate or disperse the seeds, then make a fruit salad.

Bats Control Insect Populations
Ask students to compute how many mosquitoes one little brown bat can eat in one summer, if it can eat 600 mosquitoes in an hour and hunts for 5 hours each evening in June, July, & Aug. Number of mosquitoes = 600 x 5 x 92.

Bat biologist field kit
Show students each of the tools in the field kit. Ask them how each tool might be used.

Resource Materials

√ *Bats, Myth and Reality,* video
√ *First Impressions,* see Teacher packet

Teaching Tips

Explain to students the difference between myths and fact. Ask students to think about why myths exist and how myths get started.

Discuss the story of Dracula and ask students if this story sounds as if it is based on fact.

Use the list of "Myths and Facts" on the next page to test students' knowledge of bats.

Discuss with students that some cultures believe bats to be good luck. Is this a myth about bats or based on fact?

Activities

Bats, Myth and Reality – video
Before watching the video ask students to list what they know about bats. After watching the video, ask them if they changed their mind about anything on their list.

First Impressions
Students explore their feelings about different types of wildlife, then write a resume for a bat.

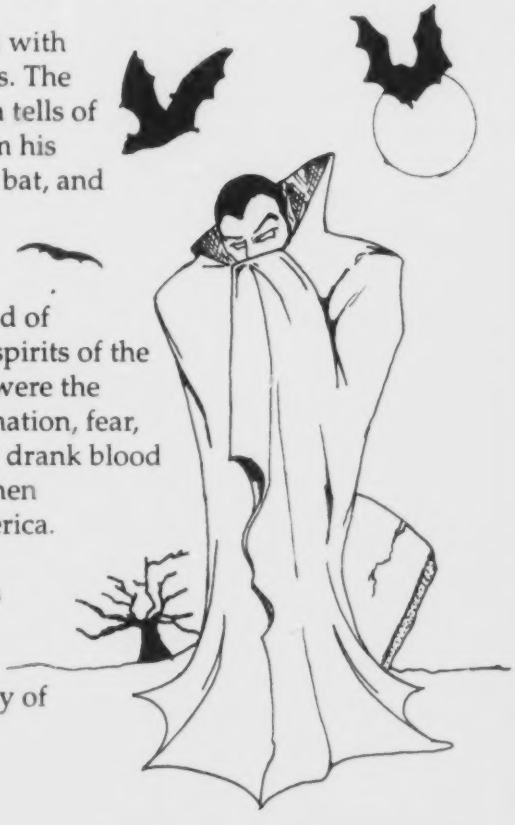
Bats in Myths and Folklore

Concept: The relationship between humans and bats is expressed through myths, religious teachings and writings, and other activities.

Myths are stories that are passed on from person to person and are not based on fact. The myth that bats are dirty is not true. Actually, bats spend a lot of time grooming themselves and each other. Bats are the subject of negative expressions such as " bat's in the belfry," "old bat," or just plain "batty." But for many cultures, bats are considered good omens.

- Gypsy children carried dried bat parts with them to bring good luck.
- Scandinavians and Germans nailed bats to doors or windows to drive away bad luck.
- In some parts of Mexico, bats are worshipped as gods.
- In Chinese art, a peach tree surrounded by five bats is the symbol for life and the five great happinesses: health, wealth, good luck, long life, and tranquillity.

Bats are often associated with evil, death, and darkness. The legend of Count Dracula tells of a person who arises from his coffin, transforms into a bat, and sucks the blood of his victims. Even before the legend of Count Dracula, stories were told of vampires that were the spirits of the undead. These legends were the result of people's imagination, fear, and ignorance. Bats that drank blood were first discovered when Europeans came to America. People named the bats "vampire bats." Legends about "blood-sucking vampires" were around long before the discovery of vampire bats!



These materials developed and provided by the Arizona Game and Fish Department Education Branch.

Myths and Misconceptions About Bats

Bats are surrounded by misconceptions and superstitions, and have always played a major role in human myths. As educators, we can present the facts and dispel the myths and fears students may have about bats. Below you will find a list of basic myths, misconceptions, and facts to help get you started.

Myth: Bats are blind and can get tangled up in your hair.
Fact: All species of bats can see – some have very good vision. Some species are equipped with a sonar-type system (echolocation), that is so sophisticated they can detect something as fine as a human hair, and avoid bumping into it. If you are standing under a street light at night, insect-eating bats may fly close to you in search of insects.

Myth: Bats are closely related to mice.
Fact: Bats are more closely related to primates (monkeys, apes, and humans) than to mice. Bats have their own order – Chiroptera, a Greek word which means "hand wing."

Myth: Bats are evil.
Fact: Bats are very beneficial to the environment. Some are very efficient insect-busters and others pollinate plants and disperse seeds. In some parts of Mexico, bats are worshipped as gods.

Myth: Bats usually have rabies.
Fact: Bats are no more likely to have rabies than any other mammal group. People are more likely to die from dog attacks, bee stings, and food poisoning than from being bitten by a rabid bat. However, you should never touch a bat if you find one on the ground or anywhere else.

Myth: Bats don't really fly, but glide like a flying squirrel.
Fact: Bats are capable of true flight, just like birds. Some bats can reach altitudes of 10,000 feet and can fly as fast as 60 miles per hour.

Myth: Vampire bats always kill their victims.
Fact: Vampire bats use their incisors to make a small V-shaped cut in a sleeping animal's skin. The bat laps (it doesn't suck) up to 2 tablespoons of blood each night, rarely waking the sleeping animal. The animal being fed on is usually not adversely affected unless it is fed on repeatedly by vampire bats.

Myth: Bats are cold-blooded.
Fact: Reptiles such as snakes and lizards are ectothermic (cold-blooded). Their body temperature changes with that of the surrounding air temperature. Bats, like all mammals, maintain a constant body temperature except when in hibernation.

Myth: Bats are dirty and likely to transmit diseases.
Fact: Bats constantly groom themselves and each other. They do not pose a serious health threat to humans.

Myth: All bats are vampires (feed on blood)
Fact: Of the nearly 1,000 species of bats, 70% eat insects, 23% eat fruit, 5% eat nectar, and only 0.3% are vampire bats.

Bat Programs & Action Projects

Game & Fish Dept. Bat Workshop

Each summer the Arizona Game and Fish Department offers a *Bat Workshop* for educators. This is a hands-on, field experience. For more information about this workshop and other educational opportunities, call 602-789-3220.

Arizona Sonoran Desert Museum

The museum has a bat exhibit and the Education Department offers outreach programs on bats. On Saturday evenings, June – October, zoo docents are on hand to discuss native bats that visit the "Beaver Pond" to hunt insects. The Arizona Sonoran Desert Museum is located 14 miles west of downtown Tucson. Every few years the Arizona Sonoran Desert Museum offers bat educational workshops. For more information about education programs and workshop opportunities, call 520-883-3067.

Bat Conservation International

BCI supports bat conservation through education, conservation, and research initiatives designed to support bats and their habitats. Members receive 4 issues of BATS magazine a year, discounts on educational gifts and products, and opportunities to participate in U.S. workshops and field projects. BCI also offers a *North American Bat House Research Project* and an *Adopt-A-Bat* program. For more information on memberships or programs, call BCI at 1-800-538-BATS or write to: Bat Conservation International, P.O. Box 162603, Austin, Texas, 78716-9721.

Bats at School?!

Two schools in Arizona are doing research on ways to discourage bats from living in their school. To find out more about their projects, call the Solomonville Elementary School at 520-428-0477 or Ray School, in Kearny, at 520-363-5513.

Phoenix Zoo

The Phoenix Zoo typically has bats on exhibit. The zoo also offers an outreach program which includes bats in the presentation. An overnight program, *Night Explorers Adventure Camp*, includes a program on bats and a nocturnal tour of the zoo grounds. Through the zoo's *Adopt-An-Animal* program you can adopt a bat. The zoo is located at 455 North Galvin Parkway, in Phoenix. For more information, call 602-273-1341.

Wildlife World Zoo

Bats are usually on exhibit in the small mammal house. The zoo also has information on how to construct a bat house. The zoo is located at 16523 W. Northern Ave., in Litchfield Park. For more information, call 602-935-9453.

Build a Bat House

The Arizona Game and Fish Department has information about how to construct a bat house. Be aware that bat houses have not been very successful in Arizona. There are few documented cases of bats occupying bat houses. With this in mind, building a bat house can still be a good group or individual project. Call 602-789-3220, or the closest Regional Game and Fish Office.

Create a Bat Newsletter

Encourage students to do research on local bats, then design a newsletter logo and monthly newsletter to distribute to other students and teachers, and parents.

Have a Bat Poster-Making Contest

Encourage students to research a species of bat and then make a poster of their species. Display the posters at a school event, mall, library, hospital, or wildlife fair where the students can educate others about bats.

For more suggestions on Action Projects see "Taking Action, An Educator's Guide To Involving Students In Environmental Education Projects," developed by Project WILD, in cooperation with World Wildlife Fund.

Activities & Masters

Elementary Bats Quiz

This quiz can be taken while students are watching the video, Elementary Bats, or used as a test after the video. The video is appropriate for grades K – 3.

1. How many different kinds of bats are there?

2. How much does the smallest bat weigh?

3. How many pups (babies) do bats have each year?

4. How many insects can a bat eat in one hour?

5. Name some different foods bats eat.

5. Name some places where you might find bats living.

6. List some colors of bats.

7. When is it OK to touch a bat?

8. How are bats similar to people?

9. How can <u>you</u> help bats?

10. List 3 things you learned about bats from the video.
    1.

    2.

    3.

Answers: 1) There are almost 1,000 different kinds of bats. 2) The smallest bat, the Kitti's hognose bat (or bumblebee bat) weighs less than a penny. 3) Most bats have only 1 pup per year, but some may have twins or even 4 pups in a litter. 4) A little brown bat can eat up to 600 mosquitoes in one hour! 5) Bats live in caves, trees, mines, buildings, bridges. 6) Bats come in many colors; black, brown, gray, yellow, red, orange, white, and spotted. 7) You should never touch a bat. It will bite in self-defense. 8) Bats are mammals – they have hair, give birth to live young, nurse their young, and control their body temperature. They have a thumb and four fingers. 9) Tell your friends and family the bat facts you have learned.

Rain Forest Allies Quiz

This quiz can be taken while students are watching the video, Rain Forest Allies, or used as a test after the video. The video is appropriate for grades 5 and up.

1. Name some places in the world where bats are found.
2. List some different foods bats eat.
3. Which senses do bats use to locate food?
4. How does the frog-eating bat find frogs?
5. How does the fish-eating bat find and catch fish?
6. What color are most flowers that are pollinated by bats.
7. Name some foods and other products that come from bat pollinated plants.
8. Name some predators of bats.
9. Name some animals that pollinate and disperse the seeds of plants.
10. "Flying fox" is another name for what kind of bat?
11. What are some reasons why people kill bats?
12. Name some ways that bats help the rain forest.

Answers: 1) Almost everywhere except the polar areas. 2) Bats eat fruit, insects, nectar, fish, frogs, small mammals, and blood. 3) Bats use echolocation, sight, and hearing, and vampire bats use smell to locate food. 4) It listens for the mating calls the frogs make. 5) It uses echolocation to detect ripples in the water, then swoops down to catch small fish with its clawed feet. 6) Bat-pollinated plants usually have light-colored flowers. 7) Bananas, figs, dates, peaches, carob, avocados, mangos, papayas, cashews, and balsa wood come from bat pollinated or seed dispersed plants. 8) Owls, snakes, beetles, and bats prey on bats. 9) Birds, butterflies, and bats pollinate plants and disperse seeds. Mammals disperse seeds. 10) Fruit bats are also called flying foxes. 11) People kill bats for food, because they are afraid of them or because they don't know much about bats. Some farmers kill bats because they think they eat their crops. 12) Bats pollinate plants and disperse seeds.

These materials developed and provided by the Arizona Game and Fish Department Education Branch.

WILD Kids

K-3 Published by the Arizona Game and Fish Department - Education Branch and the Heritage Fund Number 15

When the sun comes up, it's back home to sleep. Ears curled up, hanging by its feet.

7

Big-eared Bat

by

_____

The big-eared bat has a thumb and four fingers, just like you.

5

But when the stars come out, it flies up and away.

2

Directions: Write your name on the line on the cover page. Color the pictures. (Hint: the big-eared bat has a dark brown body and wings, and light brown ears). Then cut along the Dotted lines. Fold each strip in half so that you see one picture on each page. Make sure that the cover is on the front and the pages are in the correct order. Then staple your booklet together.

The big-eared bat hangs upside down all day.

1

But a bat can fly, don't you wish you could too?

6

It catches beetles and moths, by making sounds we can't hear.

3

The sounds bounce off insects and back to the bat's big ears.

4

WILD Kids

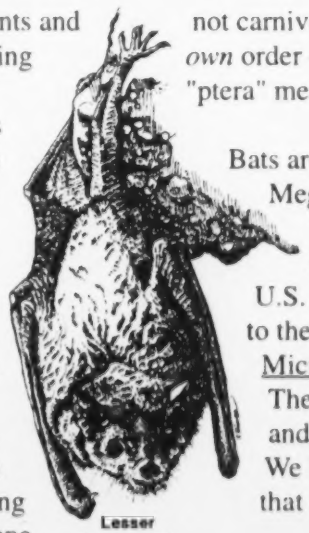
7-12 Published by the Arizona Game and Fish Department - Education Branch and the Heritage Fund Number 15

Classify a Chiropteran

To keep track of the millions of different plants and animals on our planet, scientists use a grouping system called "taxonomy". In taxonomy, scientists *classify*, or group together, animals with similar characteristics. All living things fall into one of the 5 main kingdoms, which further divide into phylum, class, order, family, genus, and species.

Look at the chart below as we classify an Arizona bat called the lesser long-nosed bat. (You'll need your pencil to do this.) First, decide which **kingdom** bats belong to. Bats are definitely animals, so circle the kingdom Animalia. Next, which **phylum** do bats belong to? All vertebrates – animals with a backbone, are chordates. Bats are vertebrates. If you circled Chordata, you're right!

Now, let's try **class**. Here's a hint: bats have fur, control their body temperature, and produce milk for their young. Yes, Mammalia is correct! Procede to **order**. This is where it gets interesting. You, apes, monkeys, and lemurs are primates. Bats are not. A few species of bats eat meat, but bats as a group are not carnivores. Bats are so unique, they have their *own* order – Chiroptera. "Chiro" means hand and "ptera" means wing. Circle Chiroptera.



Lesser long-nosed bat

Bats are further divided into 2 **suborders**, Megachiroptera and Microchiroptera. The large fruit-eating bats belong to the suborder Megachiroptera. All bats in the U.S. are classified as microbats, they belong to the suborder Microchiroptera. If you circled Microchiroptera, you're absolutely right! There is only 1 family of Megachiroptera and 17 families of Microchiroptera. Note: We have listed only the 4 families of bats that occur in Arizona.

The lesser long-nosed bat has a leaf-like flap of skin at the base of its long nose. This is characteristic of the **family** Phyllostomidae – the leaf-nosed bats. Circle the family Phyllostomidae. The lesser long-nosed bat belongs to the **genus** *Leptonycteris* (circle *Leptonycteris*) and its **species** name is *curasoae*. Now, put together the genus and species names. Congratulations, you have successfully classified *Leptonycteris curasoae*!

Kingdom	Monera	Protoctista	Fungi	Plantae	Animalia
Phylum	Arthropoda		Chordata	Mollusca	
Class	Aves	Mammalia	Amphibia	Reptilia	
Order	Chiroptera		Primates	Carnivora	
Suborder	Megachiroptera			Microchiroptera	
Family	Moormoopidae	Vespertilionidae		Phyllostomidae	Molossidae
Genus	Moormoops	Euderma	Leptonycteris	Choeronycteris	Antrozous
Species	megalophylla	maculatum	curasoae	mexicana	pallidus

More Bat Families

The 28 species of bats that live in Arizona are divided among four families. We have talked about the family Phyllostomidae – the leaf-nosed bats. There are three species of leaf-nosed bats in Arizona. The other three families of bats in Arizona are:

Vespertilionidae – also called "evening bats." Most are small, relatively plain-looking bats with small to medium-size ears, but some are medium-size with large ears. Some have colorful fur. All species in Arizona are insectivores.

Moormoopidae – called the "mustached" or "ghost-faced bats." They have large lips with folds and bumps, and eat insects. There is only one member of this family in Arizona – the ghost-faced bat.

Molossidae – these are the free-tailed bats. The end of the tail extends beyond the tail membrane. All five species in Arizona are insectivores.

Guide to Scientific Names

The scientific names (genus + species) for animals are *italicized* and often come from Latin or Greek words. The scientific name for the Occult little brown bat is *Myotis lucifugus occultus*. *Myotis* means "mouse-earred," *lucifugus* means "flees the light," and *occultus* means "secretive." Some other words associated with bats are: *nycteris* which means "bat," *Antrozous* which means "a cave animal," and Vespertilionidae which means "evening bat." Here are some fun ones: *Choero* means "young pig," *maculatum* means "spotted," *tadarida* means "dried up toad," *euderma* means "great skin," and *pallidus* means "pale in color." In some cases, the species name refers to where the bat occurs.

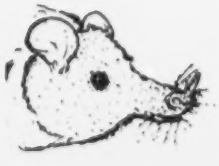
Bat Fun Facts

The largest bat in Arizona and the U.S. is the Greater Western mastiff bat. It can weigh up to 2 ounces and has a wingspan of almost 2 feet. The smallest bat in Arizona and the U.S. is the Western pipistrelle. It weighs only $^{1}/_{10}$ of an ounce and has a wingspan of about 8 inches.

Try This!

I. Read the descriptions of the following Arizona bats. Classify each bat. Start with kingdom and end with family. Using the "Guide to Scientific Names", translate the scientific name (genus + species) for each bat.

A.



Mexican long-tongued bat
Choeronycteris mexicana

Has a leaf-like flap on its long nose. This bat feeds on nectar and pollen.

B.

Pallid bat
Antrozous pallidus

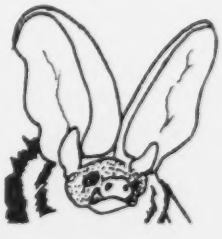
A medium-size bat with large ears. Light yellow on the back and cream-colored on the underside.

C.

Mexican free-tailed bat
Tadarida brasiliensis

Its tail extends beyond the tail membrane. This bat can fly 65 miles per hour.

D.



Spotted bat
Euderma maculatum

This colorful bat has the largest ears of any American bat. It is one of the rarest bats in Arizona.

II. Now that you are an expert in taxonomy, try classifying your *shoes* among those of your classmates. You could start with your shoes belonging to the "kingdom" of all shoes. Then decide which "phylum" they belong to: the phylum of canvas shoes, leather shoes, or other fabric. Got the idea? Keep going until you decide on a scientific name for your shoes (genus + species). Note: Family names end in"idae."

WILD Kids

4-6 Published by the Arizona Game and Fish Department - Education Branch and the Heritage Fund Number 15

Bats Eat Bugs

and other good things

There are almost 1,000 different kinds of bats! Most bats eat insects, and some eat fruit and *nectar*. Nectar is the sweet liquid of flowers. A few bats are carnivores. They eat meat – small mammals, frogs, fish, and other bats. Less than 1% of bats feed on blood.

Insectivores (insect-eaters)

Big-eared bat

Most of the bats that live in Arizona are insectivores – they feed on insects. Insect-eating bats usually have small eyes and large ears. They use echolocation to find their way in the dark and to find food. Echolocation is a special hearing system. Bats make high-pitched sounds, then listen for the returning echoes. Some insect-eating bats have a nose leaf (a flap of skin), which probably helps direct echolocation sounds.

Insect-eating bats use one or more of these hunting styles:

Fast food on the run – the Mexican free-tailed bat flies high, at 65 miles an hour, catching its favorite food – moths.

Swoop and snack – the long-eared myotis bat (myotis means "mouse-eared") flies low, then swoops down to snatch insects off plants.

Stalk and munch – the pallid bat lands on the ground and stalks its prey (beetles, scorpions, and centipedes).

Frugivores (fruit-eaters)

Flying fox

The large fruit-eating bats are called "flying foxes." They live in tropical areas of Africa, Asia, and Australia. They find food using their senses of sight and smell. Flying foxes have large eyes and a long nose.

Nectarivores (nectar-feeders)

Lesser long-nosed bat

A few bats of Arizona are nectarivores – they feed on nectar. They use their keen senses of smell and sight to find nectar and pollen. They usually have a long nose and a long, thin tongue.

Nectar-feeders flower hop. As they fly from flower to flower drinking nectar, pollen grains stick to the fur on their head and shoulders. The pollen grains drop off onto other flowers, pollinating them. The lesser long-nosed bat is an important pollinator of the saguaro cactus. This bat is endangered because of habitat loss.

Some plants have special flowers that attract bats. These flowers open at night, are white in color, and have a strong musky scent, or hang so bats can reach them easily.

Sanguivores (blood-feeders)

Vampire bats live in Mexico, Central America, and South America. They use echolocation to find their way in the dark. They use their senses of sight, smell, and hearing to find food. Vampire bats listen for the breathing sounds an animal makes. Once they have found prey, scientists believe the bats use heat-sensing pits on their nose, to find blood vessels that are close to the skin's surface. Vampire bats do not "suck" blood, but instead lap it up.

A Batty Poem

Bats are mammals
like you and me.
Some live in caves
and some live in trees.

Bats are nocturnal
they are active at night.
No bats are blind,
some have *good* sight.

They use echolocation
to find insects they eat.
They can fly at 60 miles per hour
and at 10,000 feet!

When the weather turns cold
and there's no food to eat
Some bats migrate or hibernate
in a deep sleep.

Some bats are pollinators
and some eat fruit.
Just look at their noses or ears,
they are adapted to suit.

So, don't be afraid
next time you see a bat.
They are part of nature
and belong just where they're at.

Bat Activities

I. Match the cartoon bat on the left to its "real" name on the right.

Lesser long-nosed bat

Mexican long-tongued bat

Spotted bat

Townsend's big-earred bat

Use these "real" bat names to draw your own cartoon bat:

silver-haired bat
big brown bat
ghost-faced bat
California leaf-nosed bat
western red bat
long-legged myotis
pocketed free-tailed bat

II. Unscramble the letters to find the word defined in each sentence. *Hint*: words can be found in the poem above or in the text on the other side.

gaetimr – travel to another place when the seasons change. _____

tarnec – this is the sweet liquid from flowers that some bats eat. _____

arntconlu – animals that are active at night.
_____

tacheoeloc – bats do this when they send out a sound that bounces off objects, back to the bat.
_____

dillap tab – this bat stalks its prey. _____

tinsces – this is what most bats eat. _____

nyfgli ofx – a large fruit-eating bat from Asia, Africa, or Australia. _____

veca – a dark place where bats may live. _____

III. Write a poem about bats. Use some of the words you unscrambled.

WILD Kids

K-3 Published by the Arizona Game and Fish Department - Education Branch and the Heritage Fund Number 12

What do Animals do in Winter?

Black Bears spend the winter in dens. Color this bear brown.

7

by: _____

Chipmunks spend the winter in underground burrows. They store nuts and seeds in their burrows. Draw an underground burrow for this chipmunk.

5

Some birds tuck their beak under their wing to stay warm. Color this bird blue.

2

Directions: Write your name on the line on the cover page. Color the pictures. Then cut along the Dotted lines. Fold each strip in half so that you see one picture on each page. Make sure that the cover is on the front and the pages are in the correct order. Then staple your booklet together.

The Western Tanager is a colorful bird that migrates to Mexico in winter. Color its head orange, its wings black, and its body yellow.

1

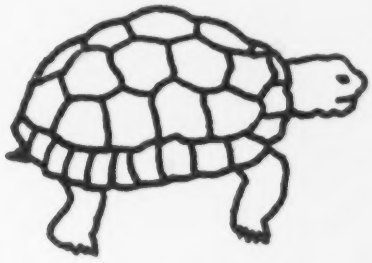
Deer grow a thick coat in winter. Give this deer a winter coat.

6

Some birds flock together and fluff their feathers to stay warm in winter.

3

Desert tortoises spend the winter in underground burrows. Draw an underground burrow for this tortoise.



4

WILD Kids

4-6 Published by the Arizona Game and Fish Department - Education Branch and the Heritage Fund Number 12

Wildlife In Winter

In winter the days are shorter, the weather is colder, and less food is available for wildlife. So, how do animals survive in winter? Because they are adapted to winter conditions in one of the following ways:

Stay Active – Some animals stay the winter and remain active. They prepare for winter by growing a thick coat and putting on an extra layer of fat.

Migrate – Many birds and bats migrate to warmer climates where food is more available.

Hibernate – Some animals hibernate to avoid cold weather and food shortages.

Stay Active and Stay Warm!

To prepare for winter, deer grow a thick winter coat that has long hollow hairs. Air trapped in between the hairs keeps the deer's body heat in and the cold air out. Shivering is another way animals make extra heat to keep warm.

Gray squirrels grow a thick winter coat, put on an extra layer of fat and feed off the nuts and seeds they have hidden. Birds fluff their feathers to stay warm. Some birds tuck one leg up underneath them and tuck their beak under their feathers to keep warm.

Ducks have a special *circulatory system* that keeps their feet from freezing while swimming in cold water. The blood vessels carry warm blood to the feet and heat the returning cold blood.

The Great Migration

In winter, birds need to eat more to keep warm. But they have less time to look for food because winter days are shorter. Many birds solve this problem by migrating. Most migratory birds are seed and insect eaters. In cold weather, trees produce few seeds and insects are scarce, so birds travel to Mexico where the weather is warmer and there is more food.

Hummingbirds

Birds that breed in the United States and Canada, but spend the winter in Mexico are called Neotropical migrants. Arizona's hummingbirds are Neotropical migrants that travel over 1,000 miles to winter in Mexico, where they feast on insects and nectar. Hummingbirds put on extra fat to help them survive their long journey.

Bats

Some species of bats migrate to warmer climates in search of food. The insect-eating Mexican free-tailed bat migrates from Arizona to Mexico – a round trip of over 800 miles! Scientists believe that changes in day length trigger migration. But how do bats know *where* to go? Some bats learn migration paths from older bats and some species use mountain ranges to help them find their way.

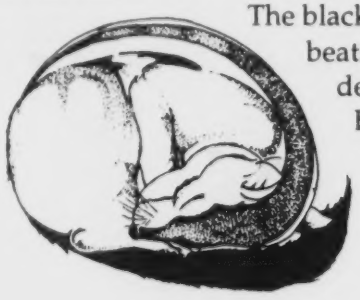
The Big Sleep – Hibernation

The word hibernate comes from a Latin word *hiberna* that means "winter." Hibernation is a special type of winter sleep in which an animal's body temperature drops to equal or close to the temperature of the surrounding environment. While hibernating, the animal's heartbeat and breathing are barely noticeable.

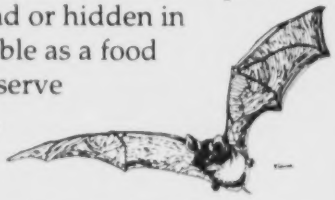
Ground squirrels and chipmunks
Ground squirrels and chipmunks prepare for hibernation by going on an eating binge! They put on an extra layer of fat to last through the winter and store food in their dens.

Ground squirrels and chipmunks enter hibernation gradually. Their body temperature slowly decreases. When a ground squirrel's body temperature drops to about 40° F it hibernates. If its body temperature falls too close to freezing (32° F) the ground squirrel will shiver or move about, increasing its heart rate, breathing, and circulation. This causes the ground squirrel's body temperature to rise and prevents it from freezing to death.

During hibernation, ground squirrels and other small mammals sleep curled up. This helps conserve body heat. Every few weeks, ground squirrels wake up to eat seeds they have stored in their burrow and to rid their body of waste, then return to hibernation. In warmer parts of Arizona, ground squirrels may not hibernate at all and you may see them above ground even in winter.



Bats
Some of Arizona's bats cope with cold weather and food shortages by hibernating. Many species of bats are *insectivores* – they eat insects. But most insects are not active in winter. They completed their lifecycles and died during the fall. The egg and larvae form of insects spend the winter underground or hidden in logs and are not available as a food source for bats. To conserve energy, bats hibernate.



Bears
Black bears spend the winter in dens. Most scientists do not consider bears to be "true" hibernators because their body temperature drops only a few degrees while in hibernation. The black bear's heart rate drops to about 8 beats per minute but it does not enter a deep sleep and can wake up quickly. Bears spend all winter in their dens – without eating, drinking, urinating or defecating!

Try This

Spell the word in the blanks below its definition.

Where bears spend the winter
_ _ ○ _

Means "insect-eater"
○ _ _ _ _ _ _ _ _ ○ _

Where insect eggs spend the winter
_ _ _ ○ _ _ _ ○ _ _ _ _

Where Arizona hummingbirds spend the winter
_ _ _ ○ _ _

Latin word that means "winter"
○ _ ○ _ _ _ _

A special circulatory system keeps ducks' feet from
_ _ _ _ _ _ ○ _

In winter gray squirrels put on an extra layer of this
_ ○ _

Some bats and birds do this in winter
_ _ _ _ _ ○ _

Use the circled letters to spell a word that means "a special kind of winter sleep." (Unscramble letters)

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

WILD Kids

7-12 Published by the Arizona Game and Fish Department - Education Branch and the Heritage Fund Number 12

Hibernation In A Hibernaculum

In winter, some vertebrates and invertebrates can enter a state of dormancy or inactivity known as hibernation. Hibernation is an adaptation to cold weather and food shortages. During hibernation an animal's heart rate and respiration decrease drastically and its body temperature falls to equal or slightly higher than the temperature of the surrounding air.

Why hibernate?

Staying warm requires a great amount of energy. Most small mammals have a high metabolism – they need to eat a lot to keep warm. In winter, they give up the struggle to stay warm and hibernate. By hibernating, they lower their body temperature and do not need to produce as much energy to stay warm. They can live off the fat reserves they accumulated prior to hibernating. Hibernation is a good way to conserve energy.

How does it work?

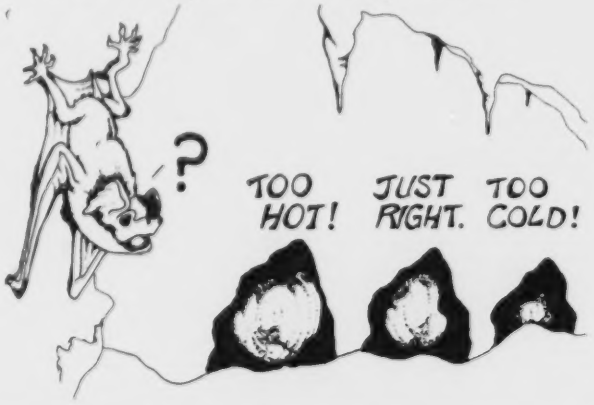
Hibernation is controlled by a part of the brain called the **hypothalamus**. The hypothalamus works like a thermostat. A thermostat is a gadget that senses changes in room temperature and switches a furnace or an air conditioner on or off to warm or cool the room. During hibernation an animal's thermostat is set lower, allowing it to maintain a lower body temperature.

Scientists have found a substance called HIT in the blood of hibernating animals. HIT stands for Hibernation Inducement Trigger. HIT goes into action when one of three things happens: when there are big changes in temperature (cold or hot), when food is scarce or when days grow shorter and there is less daylight.

Only small and medium-sized animals hibernate. Many species of rodents and bats hibernate in response to food shortages and cold weather. Bears are not considered to be "true" hibernators because their body temperature drops only a few degrees and they can awaken very quickly. Large mammals would have difficulties in awaking from hibernation due to the great amount of energy required to raise their body temperature back to normal.

How to choose a Hibernaculum?

Animals carefully choose their *hibernaculum* – hibernation site. It must be cold enough to allow the animal's body temperature to drop low enough that the animal becomes dormant or inactive. In this dormant state the animal's metabolism is slower, allowing it to efficiently conserve energy. The hibernaculum must not be *too* cold or the animal may freeze to death. Most rodents hibernate in underground burrows where the temperature is fairly constant.



Bats choose a hibernaculum that is not only cold, but humid. This prevents the bats from dehydrating. The hibernaculum must also provide protection from light, noise, and predators.

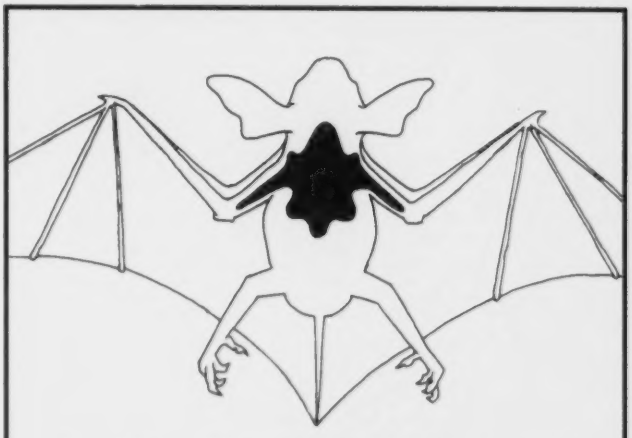
Hibernating bats should never be disturbed. In waking from hibernation the bats may use up their fat reserves and not survive the winter.

Wake Up!

Animals can arouse or "wake up" from hibernation when necessary. If a hibernating bat's body temperature falls too low, it may shiver to produce body heat or it may wake up completely and move to a warmer place in its hibernaculum. Arousal from hibernation requires a great amount of energy.

To become active again, the bat must raise its body temperature from 40° F to 100° F in a short period of time! The energy needed to raise the body temperature comes from a tissue called *brown fat*. Patches of brown fat are most noticeable around the shoulders and back, where it can quickly send heat energy to vital organs – the brain, heart and lungs. Brown fat delivers quick energy whenever it is needed.

Brown fat sends a burst of energy to the brain first. The brain can then send messages to the rest of the body to wake up. Next, brown fat sends energy to the heart and lungs to increase heart rate and respiration. The anterior parts of an animal (the head and front legs) wake up from hibernation first and may be 15 degrees warmer than the back legs. Only after the head and front legs warm up do the back legs get a burst of energy and awake. Within 30 minutes a Big Brown Bat is fully warmed and capable of normal activity!



Location of brown fat on the back and shoulders of a bat.

Try This!

When waking from hibernation, a Big Brown Bat's body temperature increases from 10°C to 38°C in thirty minutes. Make a graph of the following data. (Put the time line on the bottom of the graph.) Draw one line representing the warming of the heart over thirty minutes and another line representing the warming of the back legs over thirty minutes. (Temperature is in °Celsius.)

Time	Heart Temperature	Back legs Temperature
0 min	10 °	10 °
5 min	12 °	10 °
10 min	17 °	11 °
15 min	20 °	13 °
20 min	32 °	18 °
25 min	38 °	28 °
30 min	38 °	34 °

1. At what time is the difference in temperature between the heart and back legs the greatest?

2. During which time interval does the temperature of the back legs increase the most? Why?

3. Convert the temperature readings to Fahrenheit. What is the bat's heart temperature at 30 minutes, when it is fully warmed?

Answers to WILD Kids 4-6

Dens, insectivore, underground, Mexico, hiberna, freezing, fat, migrate. A special type of winter sleep is *hibernation*.

Answers to WILD Kids 7-12

1. At 20 minutes the difference between the heart temperature and the back legs temperature is 14°C.
2. Between the 20 and 25 minute interval the back legs temperature increased 10°C. The heart and anterior part of the body has experienced a great amount of warming up to this point. Now, brown fat is sending a burst of energy to warm the back legs.
3. The formula to convert Celsius to Fahrenheit is 1.8C+32=F.
10°C=50°F. 11°C=51.8°F. 12°C=53.6°F. 13°C=55.4°F.
17°C=62.6°F. 18°C=64.4°F. 20°C=68°F. 28°C=82.4°F.
32°C=89.6°F. 34°C=93.2°F. 38°C=100.4°F.

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Bat Jeopardy!

For The Record

10. The largest bats in the world have wingspans of up to _____ feet.

    A. 4
    B. 6
    C. 8

    Answer: B

20. There are almost _____ different species (kinds) of bats in the world.

    A. 150
    B. 500
    C. 1,000

    Answer: C

30. Bats form the largest colonies (groups) of any mammal. Some live in colonies of more than _____ individuals.

    A. 100,000
    B. 20 million
    C. 2 billion

    Answer: B

40. The smallest bat in the world, the bumblebee bat, weighs about the same as a _____ and its body is slightly larger than a _____.

    A. Half dollar/egg
    B. Orange/banana
    C. Dime/jelly bean

    Answer: C

Food

10. All but 2 species of bats in Arizona feed on insects. Some bats can catch up to _____ mosquitoes in one hour.

    A. 250
    B. 600
    C. 1000
    D. 10,000

    Answer: B

20. The endangered lesser long-nosed bat eats the nectar and pollen from which of these desert plants.

    A. Saguaro
    B. Agave
    C. Organ pipe

    Answer: A, B, & C

30. An insect-eating bat can eat how many times its own weight in food each night?

    A. 1/2
    B. 1 1/2
    C. 2
    D. 2 1/2

    Answer: B

40. Pallid bats eat some types of venomous animals. Which of the following do pallid bats eat?

    A. centipedes
    B. scorpions
    C. Gila monsters

    Answer: A & B

Bat Jeopardy!

Natural History

10. True or False: Some species of bats are blind.

    Answer: False

20. True or False: All bats have rabies.

    Answer: False

30. How many pups (young) do most bats have per year?

    A. 1
    B. 2
    C. 4

    Answer: A

40. Where on earth are bats *not* found?

    A. Australia and New Zealand
    B. Most deserts
    C. The polar regions

    Answer: C

Bats & People

10. Name 2 ways people can help bats.

    Answer: Put up bat boxes, tell friends about bats, don't go into bat roosts, and report anyone hurting bats to the authorities.

20. Name 2 ways human activities can hurt bats.

    Answer: Intentional poisoning, pesticide use, killing, shooting, or hitting bats, disturbing hibernating bats, being loud in caves, filling in abandoned mines.

30. All bats do not have rabies, so when is it OK to pick up a bat?

    A. When you find one on the ground
    B. When you know it is dead
    C. Never!

    Answer: C

40. Name 2 things bats do to prepare for winter.

    Answer: Some migrate, some hibernate, some do neither – they stay active all winter, and some build

Build A Bat

This activity is adapted from the Indiana Project WILD activity "Build A Bat", which is an adaptation of the Project WILD activity "Fashion A Fish". Fashion A Fish is found on page 88 of the Aquatic Project WILD Activity Guide, 1992.

Materials: One set of adaptation cards for each group of students

Objectives: Students will be able to:
1) describe adaptations of bats to their environments
2) describe how adaptations help bats survive in their habitats
3) interpret the importance of adaptations in animals

Method: Students design a bat, adapted for its habitat.

Background: Bats are adapted to living in a variety of habitats. They are found in most habitat types, from desert up to the treeline. Bats are the only mammals that can truly fly. The adaptation of flight allows them to travel long distances in search of suitable habitat which provides food, water, shelter, and space. Bats are also adapted to a variety of food sources: insects, fruit, nectar, blood, and meat.

All populations of animals have slight variations between individuals. Over long periods of time those animals with the best chance of survival lived to pass on their physical and behavioral traits to their young. These adaptations are features that increase the animal's likelihood of surviving in its habitat. When a habitat changes, either slowly or suddenly, species of animals with adaptations that allow them many options are the ones most likely to survive. Some species have adapted to such a narrow range.of habitat conditions that they are extremely vulnerable to change. These animals may be so specialized that they are more vulnerable than other species to death or extinction.

Procedure: In this activity, students design a kind of bat. Divide students into 6 (or fewer) groups. Each group of students will be given a set of adaptation cards which will determine the adaptations their bat will have. Each group will have one "food" card, one "navigation" card, one "roost" card, and one "color" card. These adaptation cards will determine the type of habitat where their bat is most likely to live. Students then draw their bat and the habitat where it would most likely be found. They should remember to include all the elements of habitat (food, water, shelter, and space) in their drawing.

These materials provided by the Arizona Game and Fish Department Education Branch.

The following discussion of adaptations should assist students in designing a habitat for their bat.

Roosts

Caves – Roosting in caves provides bats an environment with a fairly constant temperature and humidity. By gathering in large groups, or *colonies,* bats can conserve energy. The ceiling of a cave is usually safe from most predators, although people have been known to kill bats gathered in large groups in caves. By hibernating, bats can conserve energy when food is scarce and avoid expending large amounts of energy in migration. Gathering in large numbers in caves has the disadvantage of "putting all your eggs in one basket." If something happens to the cave or the colony of bats, a large portion of the population may be lost.

Buildings – Buildings give bats a place with a fairly constant temperature and humidity, and safety from most predators. However, inside a building bats are closer to people. This may be dangerous to the bats because many people do not want bats in their buildings. Bats may roost inside a building, under the siding or in the eaves of the building. Buildings with outdoor lighting attract insects, which are a food source for most bats.

Bridges – Bats often use bridges as daytime roost sites in tropical and subtropical areas, and as summer roost sites in more temperate areas. Bats that roost under bridges are exposed to daily changes in temperature, humidity and light conditions. The pallid bat and Mexican free-tailed bat often roost under bridges.

Trees – Bats that roost in trees must either live in a warm climate, move to a warm place to hibernate, or migrate when cold weather comes. Often bats that hibernate in caves will live under loose bark of trees during the summer. Bats also roost inside hollow trees. Trees along streams or rivers are common roost sites because bats can then fly out over the water to catch insects.

Food

Insects – Many species of bats eat insects. Most use echolocation to find insects. After locating the insects, some use their tail membrane to scoop up the insects. They pass the insect to their mouth without pausing in flight. Insects provide a plentiful supply of food for bats.

Nectar – Bats that eat nectar use their senses of sight and smell to locate flowers. Nectar-feeding bats are very important in the pollination of many plants, especially night-blooming ones.

Fish and Frogs – Bats that eat fish or frogs usually have large rear feet which they use to capture their prey. They catch their food much the same as birds of prey; they swoop down and grab it with their feet.

Fruit – Fruit-eating bats find their food using their senses of sight and smell. They are very important in the seed dispersal of many plants.

Blood – There are only 3 species of bats that feed on blood. These vampire bats live in the New World tropics and feed mostly on the blood of cattle and other domestic animals such as chickens and goats. The vampire bat lands near its prey, then "walks" closer. Using its sharp incisors, a vampire bat makes a V-shaped cut on the animal and begins to lap up blood. The vampire bat's saliva contains an anticoagulant to keep the blood flowing. After its meal the vampire bat crawls away, often without the animal even knowing it was bitten.

Navigation

Echolocation – Most bats have the ability to send out high frequency sounds which bounce off objects and back to the bat in the form of echoes. Through this special hearing system, bats can detect and track insects. Bats that echolocate have specialized ears and some have a noseleaf (a flap of skin) which helps direct the echolocation sounds.

Sight – The expression "blind as a bat" is not accurate. All bats can see, even those that depend on echolocation to find food. Some bats have very good vision. Fruit-eating bats usually have large, well-developed eyes which help them find fruit in the dark.

Smell – Many bats have a well-developed sense of smell and use it to locate food such as ripe fruit or the sweet nectar of flowers. Bats with a good sense of smell usually have a long nose.

Hearing – Bats that echolocate emit high-pitched sounds, then listen for the returning echoes. Other bats use their hearing to detect animal sounds. The pallid bat listens for the sounds of crawling insects. Some frog-eating bats listen for the calls of the frogs they prey upon. Vampire bats listen for the breathing sounds animals make.

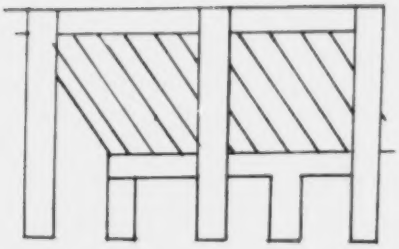
Color

Bats display quite a variety of colors. Although the advantages of color are not as obvious, color probably has to do with maintaining body heat, camouflage, and attracting mates.

The following bats pictured on the adaptation cards are found in Arizona:

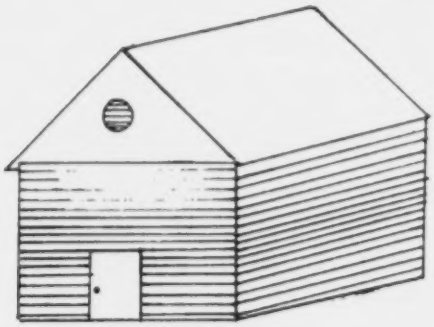
- Pallid bat
- Mexican long-tongued bat
- California leaf-nosed bat
- Townsend's big-eared bat
- Lesser long-nosed bat
- Spotted bat
- Mexican free-tailed bat

Roosts



Bridges

Roosts

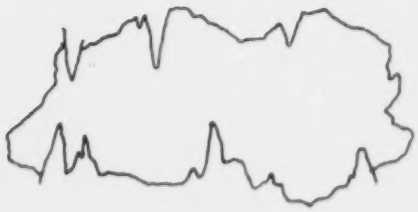


Buildings

Roosts

Caves

Roosts



Caves

Roosts

Trees

Roosts

Trees

California leaf-nosed bat

Navigation

Sight & Echolocation

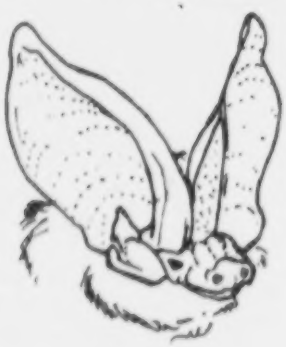
Fruit bat

Navigation

Smell & Sight

Townsend's big-eared bat

Navigation



Echolocation

Horseshoe bat

Navigation

Echolocation

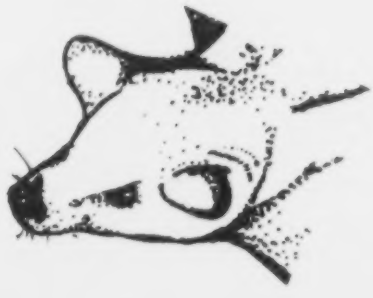
Frog-eating bat

Navigation

Echolocation & Hearing

Lesser long-nosed bat

Navigation



Echolocation & Smell

Fishing bat

Food

Fish

Fruit bat

Food

Fruit

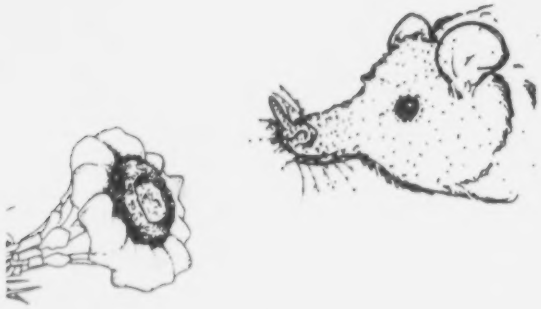
Pallid bat

Food

Insects & Arachnids

Mexican long-tongued bat

Food



Nectar

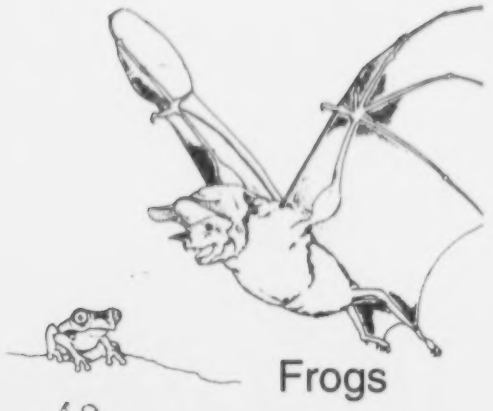
Vampire bat

Food

Blood

Frog-eating bat

Food

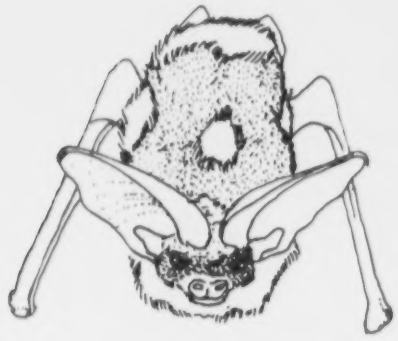


Frogs

Build A Bat Cards

Spotted bat

Color



Spotted

Chapin's free-tailed bat

Color

Brown with White Crest

Gray-headed flying fox

Color

Gray with Orange Collar

Pallid bat

Color

Brown Wings, Light Yellow Body

Mexican free-tailed bat

Color

Brown

Townsend's big-eared bat

Color

Brown

Menu

Bats are very important in the pollination and seed dispersal of many plants. Below is a list of products that come from plants that bats pollinate or disperse the seeds.

Bananas
Guavas
Peaches
Figs
Cashews
Carob
Avocados
Cloves
Balsa Wood
Mangos
Dates
Sisal
(used to make rope)

Bat Biologist Field Equipment

Bat detector – To locate bats (modifies echolocation sounds).

Mist nest – A very fine woven net used to capture bats for study.

Scissors – For cutting mist net if a bat gets too tangled up.

Gloves – To protect hands from bats that bite or scratch.

Headlamp – To see in the dark and keep both hands free.

Scale – For weighing an individual bat.

Plastic baggie – To hold bat in while weighing it (weigh bag 1st).

Ruler – For taking measurements on bats.

Magnifying glass – To take a closer look at bat teeth, wings etc.

Tweezers – To remove parasites (ticks, etc.) from bats.

Containers – To hold parasites (ticks, etc.) removed from bats.

Pillow case – For transporting bats to study later.

Pencils – Two (in case one breaks) to fill in bat data form.

Bat Data Form – To record data.

(It is recommended that anyone doing bat surveys receive the rabies vaccine.)